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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Clay Products Machinery

PUBLISHED MONTHLY BY
THE TEXAS COMPANY, U.S.A.
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICANTS
For
Brick and Hollow Tile Plants

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Table Lubrication		*

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Cams	TEXACO TEXOL "C" OR ALEPH OIL
Chains	TEXACO CRATER COMPOUND NO. 1
Press Lubrication	*

*NOTE: Recommendations for Table and Press lubrication depend on the character of the clay, etc. Our Engineering Department will make specific recommendations on request, after suitable consideration of the conditions to which the oil will be subject.

THE TEXAS COMPANY, U. S. A.

Texaco Petroleum Products

Dept. H, 17 Battery Pl., New York City

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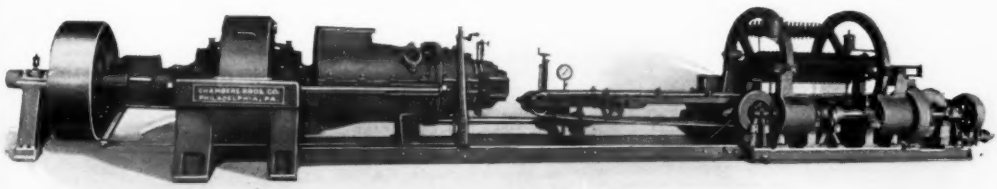


Courtesy of Chambers Brothers Company.

Fig. 1.—A multiple Brick Cutter, showing the auger machine, the delivery belt, the cutter reel and table.

Lubrication of Clay Products Machinery

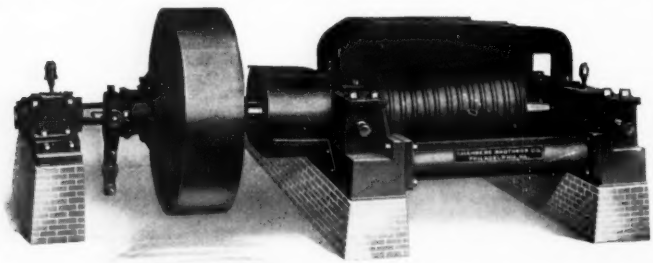
ACCORDING to recent census figures, an analysis of the Clay Products Industry showed a total of 569,709 primary Horse-power involved. In this connection, steam, electric and internal combustion engine power is utilized. In the generation of the greater part of this Horsepower and the development of the necessary heat for drying and firing, approximately 15,000,000 tons of coal or its equivalent are used annually. In fact, the clay products industry ranks third among the coal consuming industries of the United States. To serve this horsepower and lubricate the necessary production machinery in use in the industry, approximately 4,500,000* gallons of lubricating oil and 1,000,000* pounds of grease are required annually at a total cost of about $1,240,000.00.*

Naturally, in an industry of this magnitude the question of economy of both fuel and power is a paramount feature. Production costs must be kept down to a minimum by the maintenance of plant equipment in the best possible condition. Largely, this is brought about by lubrication. In the clay working industry as in many others, the wearing parts of much of the machinery are subjected to considerable abrasive wear due to the prevalence of dust, dirt, water and mud. Furthermore, the labor available may be often careless, so that it is absolutely essential to protect valuable machinery against possible resultant negligence. The most adaptable means of insuring this has been found to be lubrication, in the attainment of which the builders of such machinery have judiciously played an important part by so designing their products that relatively automatic lubrication is made possible. Therefore, in a working plant it is but necessary for the management to cooperate with their oil company, first in the selection of suitable grades of lubricants and second in their careful and intelligent application.

The working of clay was at one time generally denoted by the word "ceramics." Today, however, this term has been broadly extended

*According to data developed by *Brick and Clay Record* and *Clay Products Cyclopedia*.

to include the making of glass, cements, abrasives, refractories, stoneware, enamel, pottery and other products. We have already covered the glass and cement industries from the viewpoint of lubrication in previous issues of LUBRICATION.* Therefore, this article will deal strictly with the working of clay, as involved in the making of brick, sewer pipe, earthenware, the various varieties of tile, sanitary porcelain, china-ware, terra cotta, etc.



Courtesy of Chambers Brothers Company.

Fig. 2.—A set of Stone Extracting Conical Clay Rolls. Clay is fed in near the smaller end of the rolls, larger stones being squeezed out by virtue of the gradually increasing diameter. Clay is discharged at the upper end. Bearing lubrication is important on this machine.

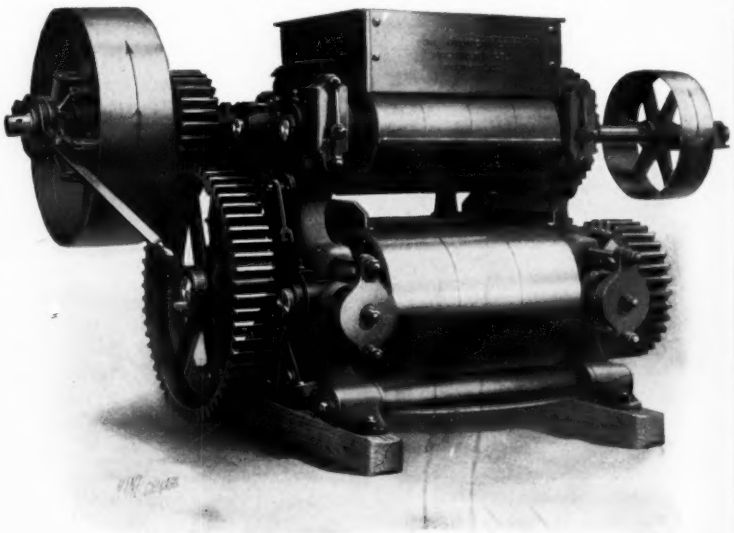
Broadly speaking, the preparation of clays prior to formation of the finished products will depend upon the nature of the latter. In some cases where long shipments are to be made, higher grades of clay especially will be subjected to a certain amount of refinement at the pits to remove as much foreign matter as possible. Frequently this includes the washing of the clay to make it homogeneous and to remove any foreign particles. It is then pumped through filter presses to remove excess water, after which it is ready for shipment to the pottery. The actual process of mining clays will not be dealt with herein, since the majority of stripping, hoisting and excavating machinery involved was discussed in detail in a previous article on "Lubrication of Excavating Machinery."** Therefore, plant lubrication is essentially the problem under consideration.

* December, 1922; May, June, and August, 1920.
** LUBRICATION, June, 1923.

BRICK AND HOLLOW TILE MANUFACTURE

The manufacture of common brick has ever been a distinctive industry, antedating perhaps even the art of metal working. Until comparatively recently, bricks were made entirely by hand, the industry being local and subsidiary to the more usual interests of agriculture and mining. Wherever there was a clay-bank perhaps the fortunate owner would intermittently mix up a batch of this product, press it by hand into crude moulds, dry the resultant plastic bricks in the sun and finally fire them in a rough wood-burning kiln. Usually his rate of production depended upon his own needs or the requirements of his immediate neighbors. Essentially, it was a side-line, rarely a business.

Later, however, building construction required a transition from this state of affairs. As a result, crude machinery was developed in the form of the tempering wheel for the purpose of mixing the raw clay. This is a wheel turning on an ever decreasing radius which is drawn round and round in a large shallow circular box or hole in the ground into which raw clay is dumped. Formerly a horse was hitched to a shaft projecting beyond the mixing pit, for the purpose of drawing the



Courtesy of The Hadfield-Penfield Steel Co.

Fig. 3.—A Compound Four Roll Crusher designed for the crushing and preparing of plastic clays. The adjustable roll bearings require careful lubrication; they are usually grease lubricated.

wheel; today, however, wherever the tempering wheel is still in service, a small steam engine or electric motor is used. Decrease in radius of rotation, whereby the wheel is continually turned through fresh clay, is attained by means of a rack and pinion device.

Courtesy of Chambers Brothers Company.

Fig. 4.—A Horizontal Clay Granulator and Feeder which serves to shave lumpy clay into smaller pieces and mix clay and sand of different varieties. Exposed gearing renders this phase of lubrication an important factor in operation.

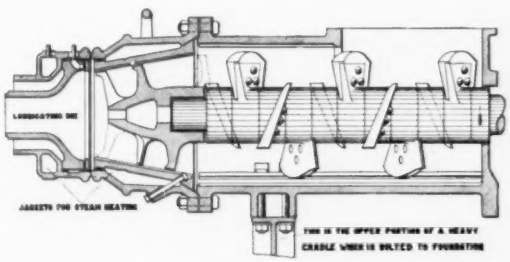
Effective as it is, however, the tempering wheel is crude and slow, therefore, the modern plant has supplanted it with such devices as the granulator, pug mill, disintegrator, dry and wet pans and conical and straight rolls. These latter are chiefly used where the raw clay is lumpy and contains stones, etc. Often a form of skip hoist, on the order of that employed in the charging of a blast furnace, is used where gravity plays a part in the subsequent handling of the clay. This hoist delivers the latter to the granulator or conical rolls which automatically throw out any stones or other foreign matter. The clay then drops to a traveling belt or conveyor for transmission to the pug mill. The granulator, as its name implies, serves essentially to break up lumpy clay; the pug mill being chiefly used for the thorough tempering of one or more grades of clay. Both machines, however, involve a steel trough in which a horizontal shaft carrying a screw or series of blades is rotated by means of a train of gears and an electric motor or belt connection from a line shaft. Where the granulator involves the first step in the breaking up of the clay, it may not do this thoroughly in which event a set of straight rolls or a disintegrator (built with rolls of different diameter) must be installed as a subsequent piece of equipment.

While the final stage in the mixing of the clay is attained through the auger machine the essential function of this device is to pass the clay through a suitable mould or die in the form of a continuous bar, which may subsequently be cut into the requisite standard lengths of finished brick or hollow tile. As its name implies, the auger machine consists of an auger-shaped shaft which is rotated in a suitable compartment by means of a train of heavily built gears. Usually an auger machine is designed for the use of an extensive number of dies of various sizes and partitions in order to facilitate not only the production of solid bricks but also of the several forms of hollow tile in general use today.

As the clay bar is compressed and forced through the die it passes onto a traveling belt which delivers it to the cutting machine. In the manufacture of brick this may be designed either for end or side cutting; hollow tile, and other forms of building tile, however, must always be end-cut. Clay cutting is usually carried out by means of a wire.

Passing from the cutter, the bricks or tile sections as the case may be, are stacked by hand onto drier cars for drying. Front or face brick, enamel brick and firebrick or other high temperature refractory shapes are, however, subjected to additional pressing before drying. This is done on a special pressing machine which not only insures a firm consolidation of the clay, but also squares up the edges and corners. Repress machines may be hand operated, or motor or belt driven, the bricks, etc., being fed to them either automatically or by hand.

Drier cars occupy an especially prominent position in the manufacture of brick and building tile, etc., the number used in the average plant generally running into the



Courtesy of Chambers Brothers Company.

Fig. 5.—An Auger Brick Machine in section, showing the lubricated die at the discharge end. This is primarily a moulding and expressing machine.

hundreds. A drier car is a relatively simple piece of apparatus, consisting chiefly of an iron frame-work mounted on wheels which run on narrow gage tracks. These cars serve to carry the various products to the drying rooms or tunnels and later to the kilns.

When the drier cars are properly stacked they are rolled (on industrial tracks) to a heated dry room where the contents are brought to practically complete dryness. The purpose

of this is to insure against cracking or warping when they are ultimately subjected to the higher temperature of the kilns.

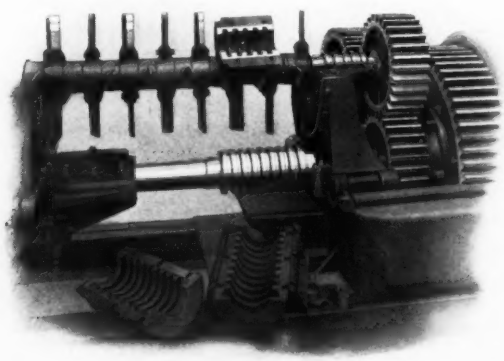
In the soft mud and dry press processes the general procedure is the same as described above for the stiff mud process, with the exception of the shaping of the ware.

LUBRICATION OF BRICK AND HOLLOW TILE MACHINERY

In practically all plants which turn out these products the machinery is massive and rugged, as can be noted from the accompanying illustrations. The fact that all, however, operate in the presence of considerable dust and dirt, and that many of their parts are subject to abnormal pressures, renders their lubrication a matter of considerable importance.

The Skip Car and Hoist

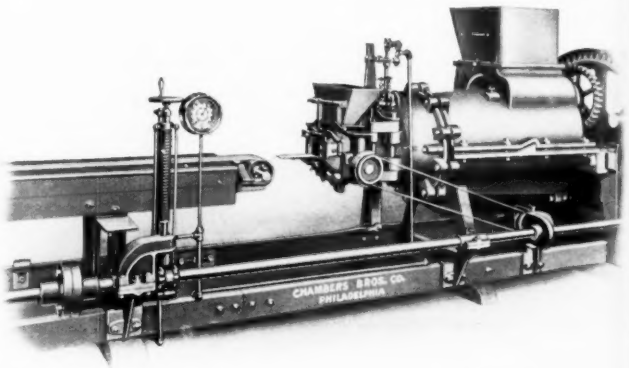
The first piece of equipment which will be met with in many brick and hollow tile plants is the hoist and skip car. Essentially this consists of a car which carries the clay from the unloading trestle or adjacent claybank to the plant. Through a wire rope



Courtesy of The Bonnot Company.

Fig. 6.—View of Constructional Details of a Combined Brick Machine and Pug Mill, showing marine type of thrust bearing which is used. This machine has an oil pan in the frame and a dust-tight gear cover to insure proper gear lubrication.

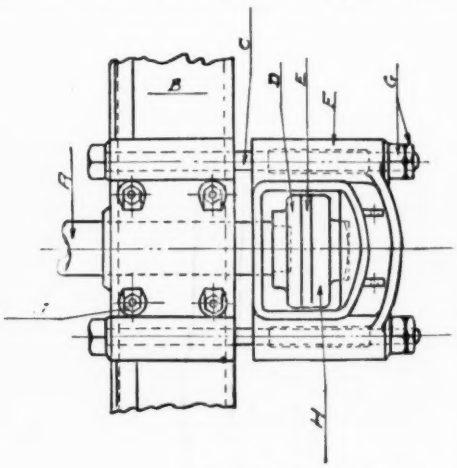
connection to a hoisting engine at the top of the skip-track, carloads of clay are periodically hoisted and automatically dumped to the granulator. Due to the fact that this rope oftentimes runs slack, taking up with a pronounced jerk at frequent intervals, its lubrication is always important; the more so as wear will tend to become abnormal. Therefore, the chief engineer should see that his wire rope is effectively lubricated with a suitable grade of semi-solid, straight mineral wire rope compound capable of not only penetrating to the core of the rope, but also lubricating and preserving the strands to a maximum. Such a lubricant is most effective when applied hot by means of a split box, through which the rope can be drawn, thereby insuring that the entire surface of the latter comes in contact with the lubricant within the box.



Courtesy of Chambers Brothers Company.

Fig. 7.—An End-cut Type of Auger Machine showing pressure pump, gauge and connections for lubricating the die with oil. The latter is applied to the back portion of the die, just as the mass of clay is being reduced to a rectangular form.

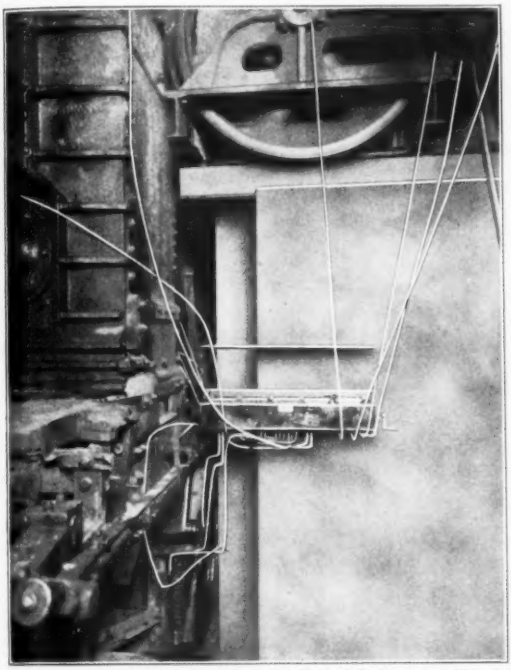
This same grade of lubricant can be used as well on the gears which drive the drum of the hoisting engine. Here it should also be applied hot, preferably to the gear teeth as they roll into mesh. It is important to remember that an excess of such a lubricant will impose a decided drag upon the machine and materially increase its power requirements.



Courtesy of The Hadfield-Penfield Steel Co.

Fig. 8.—Plan view of an Auger Machine Thrust Bearing of the floating end type. "D" is the revolving member attached to the auger shaft "A"; "E" is a disc free to move or remain stationary according to the lubricating requirements; "H" is the stationary member; and "I" the oil-tight casing which contains the above parts.

The several bearings of the hoisting engine, as well as the steam cylinders, if it is steam driven, should be lubricated with the usual power plant lubricants which are used in the engine room. In general a straight mineral oil of from 200 to 300 seconds Saybolt at 100° F. will be suitable for practically all external bearings in the brick and tile plant regardless of whether they are ring oiled, pressure lubricated, or served by oil cups or an oil can. Skip car wheel journal bearings in turn can be lubricated with the same product, or perhaps even black oil. Where roller bearings are installed on these cars, however, a special grade of grease capable of remaining within the bearing should be used.



Courtesy of McCord Radiator and Mfg. Co.

Fig. 9.—A Mechanical Force-Feed Lubricator installed on a Lancaster Iron Works Autobrick Machine, showing the necessary connections leading to the essential wearing parts.

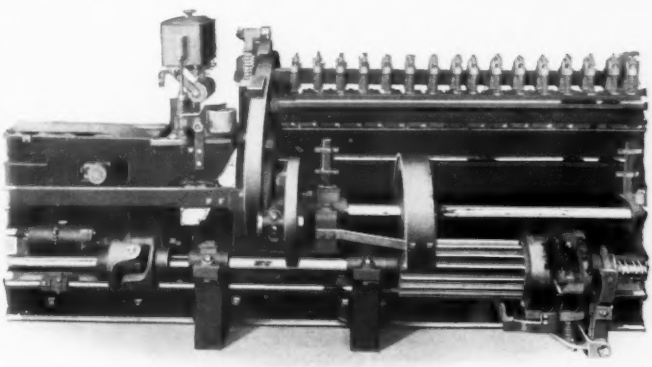
Conical and Straight Rolls and Disintegrators

Essentially bearings are involved in this equipment, with perhaps reduction gears where they are motor driven. Unless clearances are abnormally great on such bearings, even though they may be subjected to rather high pressures, the grades of engine oil specified above will be suitable. It is rarely good practice to attempt to use a heavier oil in order to fill up high clearance spaces, where such occur, for the increase in fluid friction which will result will increase power consumption to a certain extent, until the temperature of operation rises sufficiently to reduce the oil viscosity, whereupon the imaginary benefits expected from the heavier oil will disappear. Rather it is better to renew bearings if necessary in such cases; operating and power savings will certainly pay for the trouble.

Gear lubrication in turn is similar to that of the hoist, and can be effected with the same lubricant.

Granulators, Pug Mills and Auger Machines

These machines are discussed together inasmuch as their general operating features which must be met by lubrication are akin. In brief, main shaft bearings, reduction gears of spur and bevel type, and the thrust bearing in the auger machine are involved. As a rule gears operate exposed as elsewhere in the plant, except on certain types of auger machines. Where exposed their lubrication requires the use of a sufficiently viscous lubricant to insure its retention by the teeth regardless of the action of pressure or the penetration of abrasive foreign matter which would tend to "ball up" the lubricant and often cause it to drop or be thrown off by centrifugal force. A straight mineral gear compound of from 1000 to 2000 seconds Saybolt at 210° F. will be adaptable for this service. Enclosed gears, however, can be run in a bath of lubricant if the gear case is sufficiently tight; in this event a more fluid product of about 200 seconds Saybolt at 210° F. may often be used.

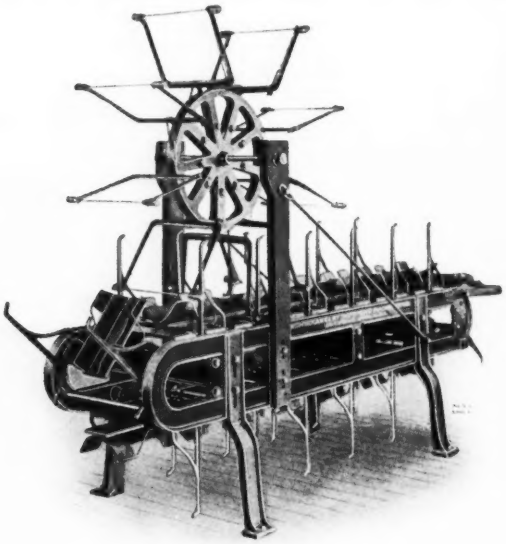


Courtesy of E. M. Freese & Co.

Fig. 10.—A Reciprocating Automatic Brick Cutter, showing oiling arrangement, branding roller and air cushion.

The bearings of these machines will be few or many, dependent upon the intricacy of con-

struction. As a rule provision is made for automatic lubrication either by means of ring or chain oilers, waste pad attachments, sight feed oil cups, multiple oilers, or compression



Courtesy of The Hadfield-Penfield Steel Co.

Fig. 11.—An Automatic Tile and Hollow Block Cutting Table. Note relation of the cutting reel to the table.

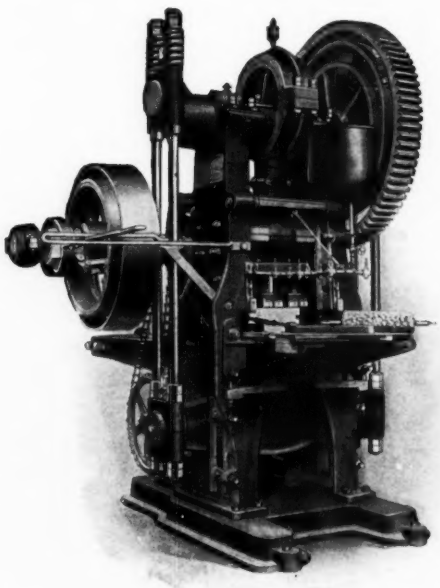
grease cups. Force feed lubrication has even been tried out on some brick machines with considerable success. The multiple or manifold oiler, and the force feed lubricator are, of course, the best propositions, since positive lubrication is assured and entry of foreign matter is guarded against as much as possible. Whatever the system of lubrication, where oil is required a straight mineral engine oil of from 200 to 300 seconds Saybolt at 100° F. will be suitable. Grease cups in turn will require a good grade of medium bodied compression cup grease.

Thrust bearing lubrication in the auger machine is the most important factor, however, which we must consider. The compressing and forcing of the clay bar through the forming die exerts a considerable back thrust upon the rear end of the auger shaft. This is usually taken up by a self-aligning, adjustable end thrust, a marine collar type of thrust bearing, or a roller thrust bearing which either runs in a bath of oil, or is served by a force feed lubrication system with a constant stream of oil by means of an oil pump operated by the machine. The selection of the proper grade of oil is usually the problem at hand. For a bath oiled thrust bearing, a straight mineral oil of from 300 to 500 seconds Saybolt Viscosity at 100° F. will be suitable. For a pressure system, however, a lighter product will often be best, having a viscosity of from 200 to 300 seconds.

In order to insure constant feed against the continual pressure exerted by the clay in its passage through the auger machine die, to relieve the machine of abnormal back pressure or thrust, and aid in the formation of a smooth surfaced clay bar, the die must also frequently be suitably lubricated. Oil, water, or steam can be used for this purpose depending upon the construction of the die and the nature of the clay. Where oil is used, a low viscosity straight mineral product is recommended by many authorities. Others, however, prefer to compound with a certain amount of fatty (animal) oil. These same products can also be used as table oils for the lubrication of the surface of the cutting machine over which the clay bar must slide. Unless this table is properly lubricated the bar may buckle, necessitating considerable loss of time and perhaps damage to the machinery. All table oils are reduced with a varying proportion of kerosene according to the nature of the oil.

Clay Cutting Machines

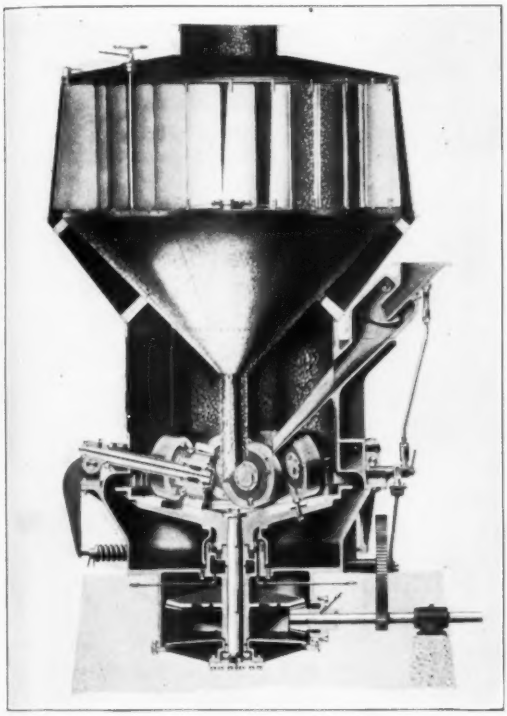
Lubrication of cutting machinery differs but little from that of the other units already discussed. Usually movable or wearing parts are the same, comprising gears and bearings. Therefore, the grades of lubricants specified above can readily be used with satisfaction.



Courtesy of The Bonnot Company.

Fig. 12.—A Repress Brick Machine which serves to press fire brick and face brick. In this machine, chains, gears, bearings and guides require careful lubrication.

Here, as on the auger machine automatic oiling equipment is installed wherever practicable to insure positive lubrication with maximum protection of the wearing parts. On such ma-



Courtesy of Bethlehem Steel Company.

Fig. 13.—Detailed view of a pulverizer showing the methods of lubricating both the gear drive and roll members. The latter are force grease lubricated through the ends of the shafts. The driving gear mechanism is oil lubricated.

chinery coordination of motion between the conveying apparatus and the cutter itself is of extreme importance. Cutting reel speed, in other words, must synchronize with the movement of the clay bar. Effective lubrication is one of the chief mediums by which this can be brought about in a properly designed machine.

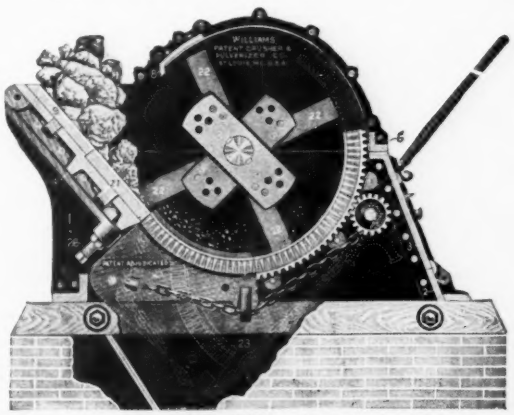
A phase of lubrication occurs here wherein the friction between clay and metal must be considered, just as in the auger die. As the clay bar slides over the table of the machine it must not bind, else coordinated operation will be materially interfered with. To insure against this the table is oiled. In many plants the lubricant is referred to as a table oil, in others it is known as a press oil, for it must also be used in lubricating the dies and guides of repress brick machines. For this work both straight mineral oils and fixed oil compounds will be suitable, reduced with kerosene as necessary. Where the product slides over the lubricated surface such as on the cutting machine, straight mineral oils will function equally as well as compounded oils. Where pressing is involved, however, the latter must be used since mineral oils alone may give rise to adhesion of the clay and imperfect delivery of the bricks. The ratio of reduction may vary from 1 to 2, to 1 to 20, according to the work at hand. All die and table oils must also be selected with a view towards obviation of scum, or discoloration of the products when dried and fired.

Repress Brick Machines

While repress machinery differs materially from any of the other equipment already discussed the essential wearing parts which require lubrication are akin. Therefore, the general grades of gear and bearing lubricants can be used as necessary. Press lubrication is also very much the same as table lubrication which has just been discussed above, though it has been found that straight mineral oils cannot be used. The only feature of difference affecting the operation of wearing parts is the amount of pressure involved. In some cases this might render it advisable to lubricate bearings and cams with a somewhat heavier grade of lubricant of even perhaps 500 seconds Saybolt viscosity at 100 deg. F. Oil is usually fed to the press forms from a storage chamber built into the machine itself.

Drier Cars

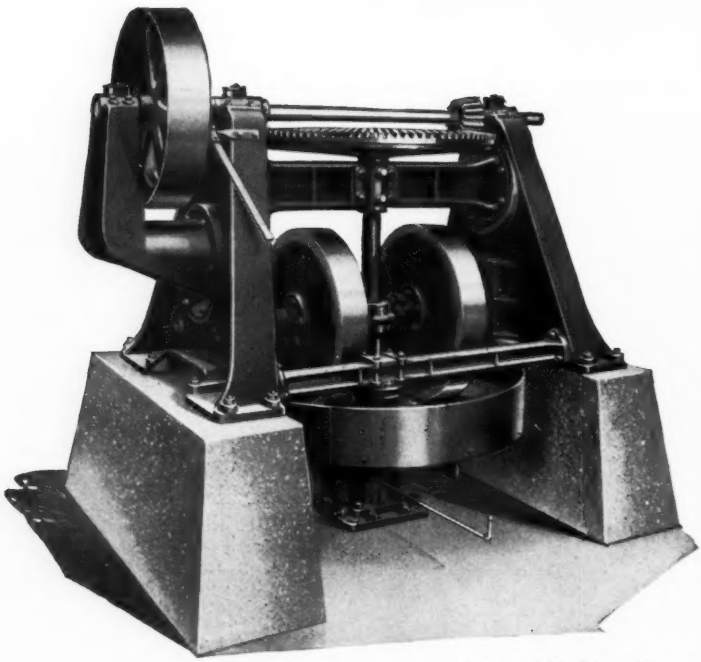
A lubrication problem due to heat is always encountered in the proper oiling of drier car wheel journals. These latter are usually equipped with roller bearings. Essen-



Courtesy of The Williams Patent Crusher & Pulverizer Co.

Fig. 14.—A Limestone and Shale Crusher showing the details of construction, and the material in course of passage. Lubrication is an important factor in the attainment of effective crusher operation, and care should be exercised in both selection and application of the lubricants.

tially the problem involved is to select a lubricant of such characteristics that it will resist the liquifying and carbonizing effects



Courtesy of The Bonnot Company.

Fig. 15.—A Typical Dry Pan, showing features of construction. Note the grinding mullers (rolls), the driving gear, and the pipe for lubricating the step-bearing. Three oil pockets in each muller spill oil on the shaft at each revolution, thus making it self-lubricated.

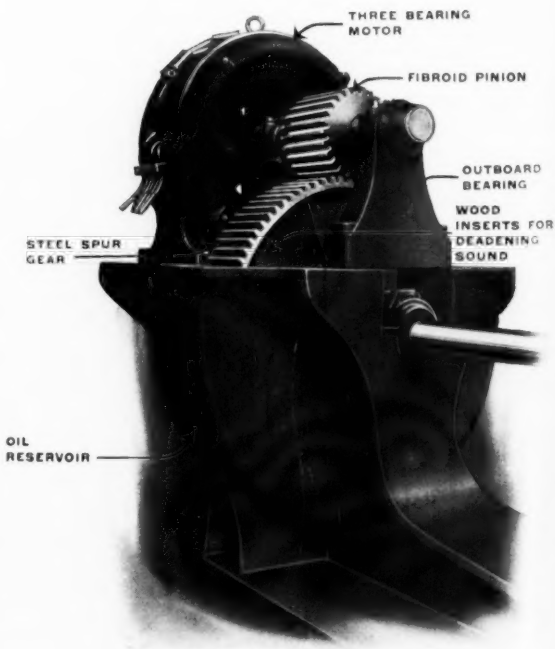
of the heat. Of course, this problem is greatest when the cars pass through continuous tunnel kilns because under the best conditions a certain amount of abnormal heat will reach them.

It has been proven in actual practice, that a semi-solid lubricant of the nature of grease, is most adaptable for the lubrication of these bearings. Ordinarily it should be a product the mineral constituent of which has a relatively high viscosity, high flash point and low carbon residue content. By virtue of these characteristics, the lubricant should remain within the bearing in plastic condition for a considerable length of time unless excessively high temperatures are encountered. As a result, it is decidedly more economical than a fluid oil would be, although its first cost might be somewhat higher.

In many plants drier car bearings are not given the proper attention from the viewpoint of lubrication; as a result they may frequently give trouble. The apparent necessity for daily lubrication, with the subsequent neglect on the part of careless employees is perhaps the reason for this. Daily lubrication, however, is only necessary where unsuitable lubricants are used. Where the product discussed above is employed it is perfectly possible to so lubricate the bearings, if properly built, that they will function satisfactorily for months without re-lubrication.

THE MANUFACTURE OF POTTERY.

In the branches of the ceramics industry which include the manufacture of pottery, architectural (floor and wall) tile, terra cotta, and sanitary porcelain, etc., the preparation of the clay is of far more importance than in brick plants. In the first place a considerably higher grade of clay is used than for the making of bricks and building tile. Usually this is free from any considerable amount of foreign matter. It is received in the plant in individual storage bins, one for each grade of clay, which is used in preparing the desired mixture. For the distribution of these products in their respective bins, overhead screw conveyors driven by belts or electric motors through silent chain connections are sometimes used.



Courtesy of The Hadfield-Penfield Steel Co.

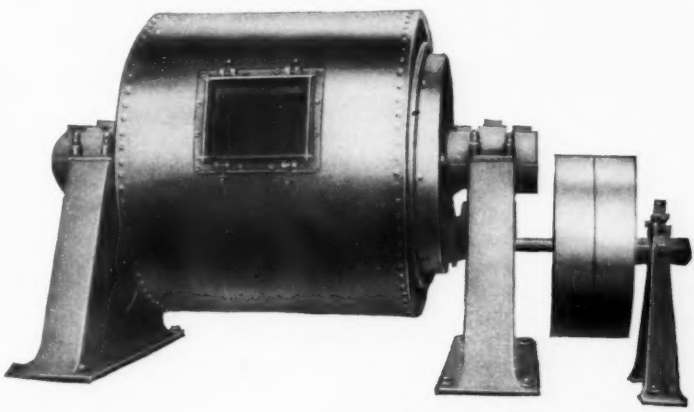
Fig. 16.—Details of the motor drive of a dry pan.

As the clay is dumped into the receiving end of each bin, the screw conveyor distributes it uniformly out to the discharge end by simply channelling the top of the pile. The mechanical equipment used in the storage department is naturally subjected to considerable dust, even though the products may be relatively dry. As a result, the lubricants used must be of such a character as to adequately protect the wearing surfaces.

Where the raw products are lumpy or mined in coarse state as are certain glaze constituents they must be ground before mixing. Usually a crusher of the reciprocating or gyratory type is used for preliminary pulverization, which is generally done at the mines. The former is preferred for the coarser materials. The resultant product is then oftentimes passed by gravity, bucket or belt conveyor to the grinding pans. These are termed wet or dry according to whether or not water is added to the product, or if the latter is wet or dry. A grinding pan is simply a large round shallow pan of 5 to 9 feet in diameter in which two or more grinding wheels are located so that their peripheral surfaces are set close to the bottom of the pan. Treatment in this machine will reduce the product to a relatively fine state of pulverization. The wet pan is used for tempering or increasing the bonding strength of the clay; the dry pan for the pulverization of clay or shale so that it can be screened to uniform size and homogeneity. They are also used extensively in the sewer pipe refractory and other heavy clay products plants. Final grinding of glaze ingredients is done in a ball mill.

From the grinding devices the product will then pass either to a pug mill or mixing device, or directly to the blungers. The pug mill has been discussed above in relation to the manufacture of bricks. Oftentimes it will not be necessary, serving as it does to simply effect a rough initial mixing of plastic ingredients. In the manufacture of sanitary porcelain, pottery and architectural tile the blunger does the real mixing. This is a vat in which suitable paddles revolve, which are actuated by an electric motor or belt connection through suitable gearing. Into this vat the clay, etc., is fed in company with sufficient water to effect a fluidity of approximately that of cream. After sufficient agitation in the blunger the mixture is pumped or run by gravity over a set of lawns or agitating sieves which receive their reciprocating motion through a motor driven eccentric connection. In some cases these sieves will simply remove coarse siliceous particles, but where the raw product is fed directly to the blungers from the bins, there may still be considerable foreign matter present in the nature of roots, stones, gravel, etc.

The product is now in a suitable state for pressing out the excess water and reduction to the plastic consistency of workable clay. This is done by pumping it through a series of filter presses under a pressure of approximately 110 lbs. per sq. inch. In fluid condition the clay is termed "Slip." The pumps in turn are known as slip pumps. These are outside packed vertical plunger pumps, motor or belt driven having from two to four cylinders. The lubrication of their plungers is one of the several problems in the industry due to the extremely abrasive nature of the flints and spars in the slip.



Courtesy of The Crossley Machine Co.

Fig. 17.—A Ball Mill or Grinding Cylinder used for the final grinding of flint, spar, color pigment, glaze or any other material requiring fine pulverization, which is to be used in the manufacture of pottery.

From the filter presses the cakes of clay pass to the storage cellar or aging room. It is sometimes necessary to store clay of this nature over an extended period; at times as much as two months time is desirable. The purpose of such storage is to enable the clay to age, in the course of which process certain organic chemical reactions take place which improve the body and reduce the subsequent tendency to crack during moulding, casting or firing. Over the period of storage in the aging room the clay is constantly covered with wet blankets or sacks, in order to prevent evaporation. After sufficient aging the clay is fed through a pug mill or auger machine in order to consolidate the material into a firm compact bar, by removing all air spaces. This bar is cut by hand into suitable lengths as it is forced

through the die of the machine, the sections being then ready for moulding or "batting" into finished shapes. This completes the mechanical treatment to which clay is subjected in many potteries and terra cotta works.

In the manufacture of vitreous china and

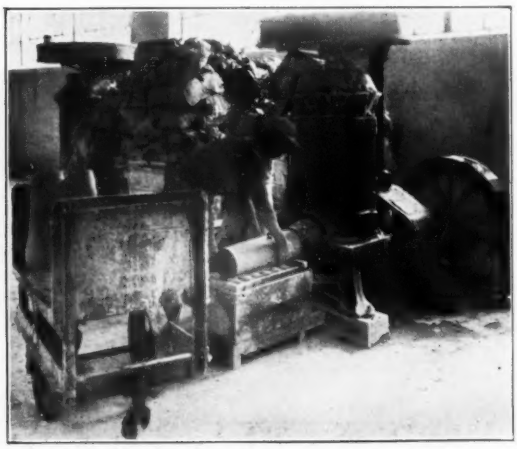


Fig. 18.—A Pug Mill installation in a pottery plant which serves to compact the clay and free it from air spaces prior to moulding.

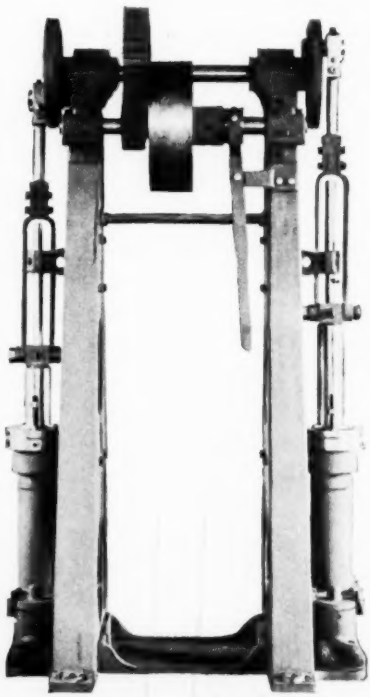
porcelain such as bath-tubs and other sanitary products, however, hand moulding has been done away with in many potteries. Their process is, instead to pass the aged clay back through the blungers to render it fluid once more, then over the sieves. Oftentimes certain other electrolytes such as the carbonate or silicate of soda may be added to defloculate the slip during the re-blunge. The resultant slip is then pumped by slip pumps through a distributing pipe line to the casting room. Here moulds of plaster of paris are set up as in terra cotta work, the only difference being that the clay flows into them instead of being "batted" in by hand. Casting naturally saves considerable time and labor though it is usually only adaptable to plants wherein standardized production is possible.

In the manufacture of architectural tile such as is used for floor and wall surfacing, etc., clay is treated by much the same machinery as described above. Usually it receives but one blunging. The clay cakes as they are taken from the filter press go to a drying room for a short period of storage. It is desirable to have the clay retain from 10 to 12% of water, however; therefore in some potteries it is dampened later before pressing. Complicated shapes such as moulding require about 1 to 2% more water. Tile making is essentially a matter of subjecting the clay to high pressure in dies of various shapes. The presses may be either motor-driven or hand-operated.

Firing

After pressing, moulding, cutting, or casting, the product must then be dried until nearly bone dry, the length of time depending on the nature and size of the piece. After this it is fired to bring about complete contraction and hardening of the clay.

The manner in which clay products must be fired will depend upon the nature of the finished piece. Some types such as common brick, electric porcelain, and terra cotta are single fired; the latter products being glazed and fired in the green state, the glaze and body maturing at the same time. Wall and floor tile, chinaware, and sanitary porcelain, on the other hand, are double fired, first in the "biscuit" at high temperature, and then at a lower temperature after glazing. Firing of clay products is one of the most important stages in their manufacture. Essentially the object is the same whether common brick or the most



Courtesy of The Crossley Machine Co.

Fig. 19.—A two-cylinder Slip Pump which serves to pump liquid clay material or "slip" to the filter presses after it has passed through the agitating sieves. Slip pump plunger lubrication is important due to the abrasive nature of the material handled.

artistic of terra cotta is involved, viz., to burn the product to a permanent state of hardness. Depending upon the product, however, more or less care must be exercised in this process.

With the more expensive products such as enamelled brick, tile, and porcelain ware, the

discoloring effect of the gases of combustion upon the glazed surfaces must be considered. Modern practice is to observe every effort to insure oxidizing conditions in the kiln. To this end some plants use kilns of the muffled type, the clay products being charged into the

Courtesy of The Crossley Machine Co.

Fig. 20.—A Vibrating Sifter or Lawn which serves to separate foreign matter from the "slip" after it has passed through the blunger.

muffled heating chamber around which the gases of combustion circulate. Larger pieces of porcelain ware such as kitchen sinks, bath tubs, etc., can now be fired in a new type of compartment gas fired kiln which does not require a muffle and yet produces a very satisfactory glazed ware.

Vitreous china such as tableware, small sanitary pieces including lavatories, closets, etc., and architectural tile are either fired in muffled kilns or inserted in clay containers known as saggers, and then fired in direct contact with the heat. In the kiln these are either set one on top of the other where the smaller varieties of ware are to be fired or else the top sagger is inverted to enclose the protruding portion of the piece above the sides of the bottom sagger. In order to prevent the direct contact of the gases of combustion with the ware, the rim of each sagger is sealed to that of its neighbor by means of clay wads. During the process of firing, the heat is regulated by observation of pyrometric test cones (termed Seger cones) inserted in the kiln. These are composed of various siliceous and mineral substances which give them varying melting points. Electric pyrometers are also used in some potteries. In addition test samples of the same composition as the ware being fired, and frequently small rings of clay which change color at different temperatures, are placed in the kiln subject of withdrawal for observation whenever necessary.

LUBRICATION OF POTTERY MACHINERY

While practically all the machinery discussed above in connection with the manufacture of tile, porcelain, and terra cotta, requires careful lubrication if production is to be maintained at a minimum cost of operation, certain of the equipment because of its construction or the conditions under which it functions, is subject to more than usual wear and tear. Especially is this true of the thrust bearings of auger machines, the plungers of the slip pumps, and the step bearings of wet and dry pans. Auger machine lubrication has been discussed elsewhere in this article under the lubrication of brick-making machinery. Slip pumps and grinding pans being more peculiar to the manufacture of tile, porcelain and similar finer wares, are discussed below.

The Slip Pump

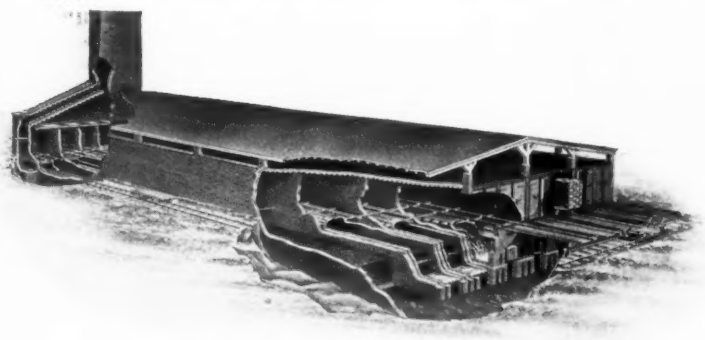
Slip pump lubrication is a relatively simple matter, with exception of the plungers, as already stated. This device can be either driven by an individual electric motor or by belt connection from a common line shaft above. In effect it comprises the usual variety of gears and bearings which can normally be effectively lubricated with the products recommended elsewhere in this article for such equipment. Due to the abrasive nature of the slip and its cutting effect upon the plunger packing, it is necessary to use a lubricant of sufficient viscosity to protect this latter as much as possible. Usually a Steam Cylinder Stock or Black Oil of Medium Viscosity will be satisfactory.

Fig. 21.—A Sagger Press on which the clay firing containers or saggers are formed. Press die lubrication is important here as on other clay pressing machinery.

Wet and Dry Pans

Wet and dry pans in turn often involve a problem in the lubrication of their step bearings. These latter are usually either of the convex plate or roller type. Considerable weight is borne by such bearings; also the possibility

of entry of dust or other abrasive material is prevalent. Therefore, they must be kept well supplied with a good grade of 200 to 300 viscosity engine oil which will furnish an adequate lubricating film to the exclusion of all foreign matter. Normally they should be protected as much as possible with a suitable dust-tight cover. Other wearing parts, such as gears and bearings, however, will seldom give trouble if well supplied with proper grades of lubricants.



Courtesy of International Clay Machinery Co.

Fig. 22.—A Metallic Radiation Drier Cut-away to show tracks for drier cars, facilities for heating and the general constructional features.

Press Lubrication

The lubrication of tile press dies and clay has a marked influence on production. The purpose of lubricating these dies or mixing oil with the raw material is to prevent adhesion of the clay and to insure the delivery of the product in the proper shape with perfectly straight edges and square surfaces. Mineral oils in compound with fixed oils have been proven to be the most satisfactory lubricants for this service, the purpose of the latter being to counteract, by emulsification, the effect of the moisture in the clay and to give a perfectly lubricated surface to the die. It is customary to prepare press oils of this nature of varying concentration and viscosity by reducing the purchased product with a certain amount of kerosene. The nature of the clay and the work at hand is usually the guiding factor in the determination of the proportion of kerosene to be added. Straight mineral products cannot be used as press oils due to the inferiority of the resultant lubricating film in the presence of water.

Miscellaneous Equipment

Elsewhere in the pottery, the gears, bearings, guides and perhaps cams which are involved on clay distributing equipment, ball mills, plungers, screens, line shafting, pug mills, sagger presses, auger machines, conveyors, and drier cars, can be adequately lubricated by the various oils or greases already mentioned in connection with brick-making machinery.

The lubrication of silent chains, electric motors and other power equipment has been so extensively discussed in recent issues of LUBRICATION* that it will not be dealt with further in this article.

Conclusion

In view of the nature of the materials being handled it can be appreciated that clay working machinery in general will require careful attention to its lubrication if production is to be maintained at a maximum and maintenance costs at a minimum. A knowledge of the several working problems involved is essential if lubrication is to be intelligently carried out.

Fig. 23.—View of a Blunger and Slip Mill Pump installation in a pottery plant.

This the above article has endeavored to impart, accompanied by sufficient explanatory data to make the information of educational value to the layman as well.

*August and November, 1923.

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